

NISTTech

Modular Suspended Manipulator

RoboCrane refinements increase flexibility and utility

Description

The RoboCrane controls suspended loads, tools and equipment through all six degrees-of-freedom without sway or rotations typical of cable suspended systems (e.g., cranes). This refinement allows modular robot reconfigurability, simple set-up and calibration, and suspension of a moving platform able to carry a robot manipulator or a human worker, or both, throughout a large work volume. The platform applies forces and torques along typical work-volume edges allowing tool control near the attachment points. It can be suspended from shallow and widely spaced attachment points.

Each RoboCrane cable may be independently controlled via a winch and powered by a power amplifier. A computer is used to determine the amount of cable-length to shorten or lengthen based on sensor inputs. As cable lengths are changed, the suspended platform remains fully controllable throughout a very large work volume. This concept is atypical of most robots. Joystick or other computer algorithm commands sent to the RoboCrane can provide complex platform motions controlled throughout the RoboCrane work volume. Pre-programmed trajectories allow the operator to pre-plan RoboCrane motions with updated path information based on sensory interaction with the environment (e.g. maneuvering around an obstacle that was placed in the pre-programmed path of the platform).

Images



Credit: N.E. Wasson Jr., U.S. Technology Corp.

Applications

- **Large scale, precision work**
May be used for large-scale manufacturing, waste storage tank remediation, construction, military, and other applications such as shipbuilding, aircraft maintenance, high bay facilities, and decontamination and decommissioning of nuclear facilities
- **Cutting**
Manipulates a variety of saws (wire saw or disc saw), rotary cutting tools (router, milling tool, grinding tool), abrasive jet tools (water jet, air jet), flame cutters, or chisels for cutting steel, plastics, or wood. The robot can produce large forces with accuracies sufficient for many types of machining operations, including milling, routing, drilling, grinding, and polishing.
- **Excavating and grading**
Manipulates digging devices (digging tools, augers, scrapers) precisely over the ground in either a manual or computer controlled mode. By suspending the arm, dirt can be removed from a large volume with great precision.
- **Shaping and finishing**
Manipulates grinders, polishers, buffers, paint sprayers, sandblasters, and welding torches over large objects (ship hulls, structural steel, casings and weldments, concrete structures). It can apply controlled amounts of force and resist perturbations in all directions.
- **Lifting and positioning**
Fitted with a variety of gripping devices to lift and precisely position loads, and exert controlled forces to mate and seat loads while resisting perturbations such as wind and inertial forces. Vacuum, water and/or air hoses can also be manipulated for removing materials from surfaces and tanks (such as waste storage tanks). Precision motions of 0.125 inches and 0.5 degrees can easily be achieved while maneuvering loads in manual, semi-autonomous, and autonomous control modes.

Advantages

- **Provides torque resistance**
With the addition of one or more servo axes, the system can resist forces and torques offset from the platform. Additional rotation angles for enabling activities such as low ceiling applications or large angle controlled rotations
- **Modular**
Provides work-volume reconfigurability and enormous reconfigurability of the suspended platform so the user may configure the invention exactly

to the application

- **Cost-effective and adaptable**

No or minimal pre-process set-up, provides the ability to move the robot, tool, and/or equipment to new locations with minimal set-up time. No additional fixturing to floors or lower level structures beneath the platform is necessary. Attaches to many structures, such as walls, ceilings, support structures, cranes, bridges, and radio towers covering a very large work volume

- **Great maneuverability**

Maneuverability from above the work site where there is typically unused work-volumes

- **Minimal recalibration**

Needs infrequent detachment and reattachment, with potential rapid, automatic calibration by a single worker

- **Uses various control modes**

Control modes, such as teleoperative, semi-autonomous, and autonomous control, are possible with this new configuration, with control of a cable driven manipulator driven to precise locations with accuracy and repeatability similar to typical serial manipulators but with higher payloads

Abstract

A cable-driven manipulator can precisely manipulate tools and loads using position, velocity and force control modes. The manipulator includes a plurality of cables (2 or more) that are independently controlled by modular, winch drive-mechanisms and coordinated to achieve intuitive manipulator movement in all six degrees-of-freedom. The manipulator consisting of modular sub-assemblies and components (i.e. winch, amplifier, servo interface, sensory feedback), can be rapidly reconfigured to adjust to new applications. Various combinations of manual and automatic control can also be implemented. The winches can be controlled manually by a multi-axis joystick, or can be automatically controlled by computer.

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References

- Docket 09-026, U.S. Patent # 6,566,834

Status of Availability

This invention is available for non-exclusive commercialization licensing.

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